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BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: Trip Report - Space Applications Summer Study, Briefing 31 July and Seminars 1-3 August, 1968, Woods Hole, Massachusetts - Case 340

DATE: August 26, 1968

FROM: B. E. Sabels

ABSTRACT

The Central Review Committee of the National Academy of Sciences Space Applications Summer Study has concluded at the end of a two year effort that more money should be put into the Space Applications Program of NASA, even though it is not feasible as yet to give a specific cost benefit analysis for the projected results. While funding levels will need to be increased to cope with technology development, it appears that the fundamental problems facing operational space sensing systems are principally administrative and political.

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MEMORANDUM FOR FILE

INTRODUCTION

The briefing and seminars held in Woods Hole from July 31 to August 3 culminated two years of work by a Central Review Committee and twelve technical panels of the National Academy of Sciences. The purpose of the study was to guide NASA in the area of space applications. A panel of experienced business men was added this year to assess the expected benefits. The briefing was attended by about 100 members of government departments and agencies, such as Agriculture, Commerce, Interior, HEW, Transportation, FAA, BOB, State, Defense, NAS, NASA, and the House and Senate. The Seminars dealt with a variety of technical and nontechnical problems such as sensing systems, payload engineering, data processing and utilization, economics, interagency and international implications. The meeting conveyed the realization that the fundamental problems of space applications are non-technical in nature. Mr. James Webb suggested that members of the Academy of Public Administration should be added if the study were to be continued. It is almost an axiom of high-level space planning that all technical problems are solved eventually, provided sufficient time and funds are available. The funding of the present space applications effort was believed to be too low by a factor of two or three for adequate technological advance within a desirable time frame. The Central Review Committee suggested that the emphasis of the national space program should be oriented towards benefits for all mankind. A spirited discussion ensued as to whether or not this is compatible with the present primary goal of the program, which is to put man into space. It was concluded that a few hundred million dollars spent on space applications will not endanger the multibillion manned space program, but the undercurrent in the opinions expressed seemed to be that the two goals of "benefits to mankind" and "man in space" warrant more equal funding.

While a detailed comparison between manned and unmanned modes was not made, the study assumed that automated satellites would be the most natural operating systems. However, sensing principles and hardware as well as data handling, analysis and distribution, and administrative and political aspects are similar or identical for manned and unmanned space applications, so that the space applications summer study will be of significance to all sensing of environment from space, including aspects of the lunar and planetary programs. In the following, some key areas discussed during the four days are highlighted.

1. General Objectives and Status

Dr. Allan Puckett, Hughes Aircraft Company, discussed uses of space technology and achievements to date. The general objective of space applications is the employment of earth orbiting satellites for direct beneficial impact on the social, economic, and industrial world. One can distinguish two broad categories of satellite uses:

1. Communications satellites (relays, repeaters)

2. Observation and sensing ("eye in the sky").

The status of the technology has greatly changed during the past ten years. There is now a large catalog of boosters. Guidance and control systems have evolved to a routine matter today what was only marginally possible five years ago, such as 1/10 degree orbital accuracies and 1/100 milliradians station keeping positions. The orbital lifetime of equipment has constantly increased, and 5-7 years is now considered reasonable. This holds for electronic and, recently, for mechanical equipment. In fact, such is the pace of technological evolution that we do not know how long a satellite can be made to last. The cost leverage of extended orbital lifetime is enormous, in that doubling the lifetime means effectively cutting the mission costs in half. Mr. Webb pointed out that the increase in systems reliability is not unrelated to the need to man-rate boosters and hardware in manned programs.

2. Areas of Application

Dr. Beardsley Graham of Comsat, and Drs. Ralph Shay and Verner Suomi discussed areas of application in communication and navigation, meteorology and earth resources.

A 600-lb. satellite in sun-synchronous earth orbit can deliver 24 channels for rebroadcast, or one channel over the time zone it covers at any moment. A geosynchronous VHF satellite over the Atlantic Ocean can serve air and sea traffic control.

A 24 channel geosynchronous satellite over India can deliver 8 channels per time zone and can carry 4 voice channels per video channel to help overcome the language barrier of the Indian people. There is a need of information on the effective use of the electromagnetic spectrum in communication ("the frequency crisis").

Satellites will be used for point-to-point communication with sensors on the ground, afloat and aloft. There are 14,000 planted sensors in existence, measuring physical parameters in remote areas of the globe. For 1975, 27,000 sensors are forecast, such as flow gauges, sea state, rainfall, wind, temperature and pressure meters. Hydrologists alone project the need for about 50,000 sensors by 1975, and some predictions go as high as 250,000. Oceanographers speak of needing about 500 buoys (which cost about $0.3 million apiece). Dr. G. Ewing of Woods Hole stated that the buoy program has a lot to offer "as long as it does not go overboard"(!). Dr. Shay pointed out that a numerical model for improved storm warnings and weather forecast would require the measurement of some 8-9 atmospheric parameters from satellites in low resolution with a repetition rate of 1-2 per day.

Earth resources satellites are approaching the development phase. In the early 1970's NASA plans call for three-band TV cameras and scanners for spectral measurement (ERTS). These would be followed in the mid - 1970's with data collection and nearly operational for user support.

3. <u>Information Systems and Technical Application</u>

Dr. A. Anderson and Dr. E. Piore of IBM stimulated a discussion on program management. From existing meteorological and geodetic data handling experience, they concluded that an evolution of data output beyond the image format must be achieved through automation as the result of aggressively managed development programs. For example, information systems can be made to "answer" specific questions, such as the distribution of specific vegetation, soil types, minerals or sea state, or to report changes of the environment beyond a preset level, rather than burden the communication links with raw image transmission. Simulated, large-scale data problems need to be attacked now. Progress will be made by doing, then by improving the inadequate first results.

The Central Review Committee agreed that the pace of the program needs to be changed. Both crash and leisure programs are known to be costly. At $100 million per year, the space applications program is believed to be moving too slowly. Doubling or tripling of the program support was suggested.

4. Cost Benefit Analysis

Mr. S. Lenher of Dupont and Dr. J. Hobbs of Lehigh University examined costs and benefits. Lenher stated that the field of space applications is not ready for conventional cost benefit analysis. During the present R&D phase, judgment, not cost benefit analysis,must be the principal concern. Industry generally requires a gestation period of 5-10 years for new developments prior to analyzing their potential benefits. In this case, this would be at the time when prototype satellites and some operational satellites have been flown. Undoubtedly, not all the benefits of the applications program will ever be measurable in dollars.

Dr. Hobbs projected some cost figures for the user disciplines of space applications for a four year time span, which are shown in Table 1.

TABLE 1. COST ANALYSIS BY DISCIPLINES
IN MILLION DOLLARS PER 4 YEARS

	Space Segment				Processing and Distribution			
	R&D	Initial Investmt.	Oper. and Maint.	Total	R&D	Initial Investmt.	Oper. and Maint.	Total
Forestry, Agriculture, Geography	16	24	18	58	7	6	56	69
Geology	7	13	12	32	2	-	4	6
Hydrology	15	57	37	109	21	12	81	114
Oceanography	14	69	56	139	50	2	20	72
TOTAL	52	163	123	338	80	20	161	261

Total $599 Million for four years

TABLE 2. COST ANALYSIS OF COMMONALITY MISSIONS
Space Segment, Seven Year Total

	R&D	Initial Investment	Operation and Maint.	Total
Polar Earth Resources Satellite	5	72	36	113
Geosynchronous Data Relay Satellite	7	28	32	67
Aircraft Radar in Geology	6	1	5	12
TOTAL	18	101	73	192

Seven year total of separate disciplines	$338 Million
Seven year total of common missions	$192 Million
Savings due to commonality	$146 Million

Furthermore, he introduced the term "commonality" of sensors in user areas and gave it an apparent economic significance by equating it with "money saved". This is shown in Table 2.

During the seminar sessions, the economic use of the commonality principle came under attack. Technical groups agreed that there is commonality in concept and in physical principles, but that it is often impossible to carry the term over into the operational sphere. Therefore, the above indicated savings appear to be largely ficticious. One well-formulated opinion was that "systems engineering is formalized common sense. Therefore, if analysis shows that commonality costs less than noncommonality - fine. If it costs more - forget it".

It was pointed out that commonality between the civilian and military programs had not been addressed in this study.

For seven year meteorology program, the projected cost figures were as shown in Table 3.

TABLE 3. SEVEN YEAR METEOROLOGY PROGRAM COSTS ($Mill.)

	R&D	Initial Investment	Operation and Maint.	Total
Space Segment	26	158	108	292
Process and Distribution	6	2	120	128
TOTAL	32	160	228	420

It is significant that all projected numbers exceed the present budget framwork of the space applications program by factors of 2 to 4.

5. National and International Considerations

Messrs. T. Malone (Travelers Insurance) and E. Ackerman (Carnegie Institution of Washington) addressed important technical and nontechnical aspects of space applications. The key question is what each user agency wants from space technology in its role as custodian of a public interest. The role and participation of government agencies other than NASA in space applications is poorly defined and in need of intensification. This becomes particularly urgent if one considers, as Dr. Malone pointed out, that, while human life on this planet from an insurance point of view will be possible for another 3 million years or so, it will take considerable planning to get through the next 100 years. It may take new kinds of institutions or organizations to solve the national and international problems surrounding space applications. Costs should be shared, and benefits should not be over-estimated nor oversold. Ficticious numbers should not be attached to intangible benefits.

6. Conclusions

Among dominant recommendations for immediate action were

1. Meteorology satellites
2. Broadcast satellites
3. Ground data processing
4. International cooperation

Two families of policy problems were recognized: Multiagency problems and international problems created by the need to develop and operate satellite systems of multi-disciplinary character. In the end, all space applications programs will outgrow the parent agency and will be government-wide and, indeed, planet-wide programs.

Mr. Webb quoted the recent Floyd Thompson study of future space flight goals*, which stated such major objectives as the greatly increased understanding of the earth and its atmosphere, and the continuous or periodic monitoring of events and changes on the earth and in the atmosphere. "Man's role in this program will add flexibility and reliability to the use of complicated instruments and sensors that are automated to the maximum degree that the designer's knowledge of requirements and his ingenuity will permit".

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*Report of the Post-Apollo Advisory Group, July 20, 1968.

Mr. Webb also pointed out that if this summer study, started by the National Academy of Sciences, were to be continued, it should include participation by the National Academy of Engineering, the Academy of Public Administration, and the U. S. Government.

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B. E. Sabels